Key

Discussion Worksheet: Redox Reactions

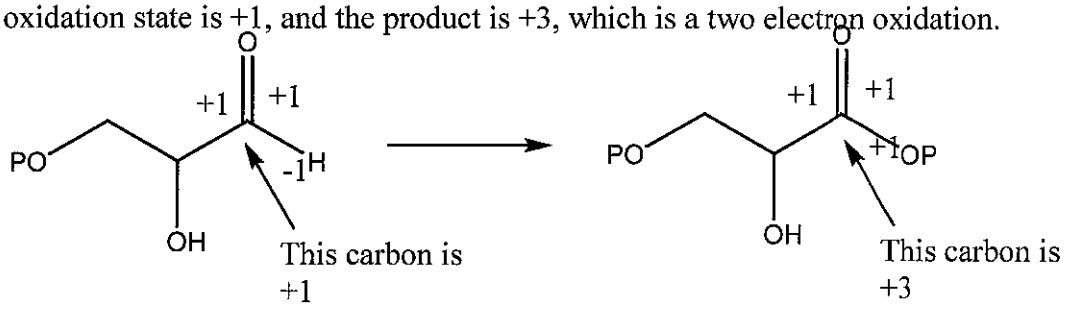
Skill 1: Using oxidation state changes to recognize redox reactions

Strategy for problem solving:

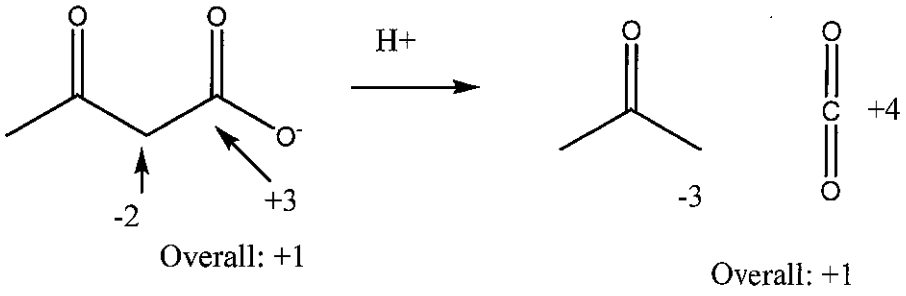
1. Identify all carbon atoms that have changed in the reaction
2. Determine their oxidation numbers
    a. Assign -1 for each C-H bond and +1 for every C-Q bond.
    b. Add assigned numbers to get the oxidation state
3. Add all oxidation states in the reactants.
4. Add all oxidation states in the products
5. Determine if there is a net change in overall oxidation state for the reaction.
    a. If the net oxidation numbers of a product increase (more positive, less negative) from reactant, then the compound has been oxidized
    b. If the net oxidation numbers of a product decrease (less positive, more negative) from reactant, then the compound has been reduced
    c. If the net oxidation numbers remain unchanged, then it is not a redox reaction

Examples:

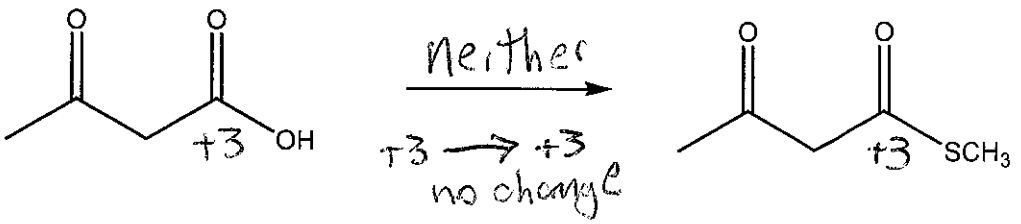
A. In this case, only one carbon atom changed in the reaction. The overall reactant oxidation state is +1, and the product is +3, which is a two electron oxidation.

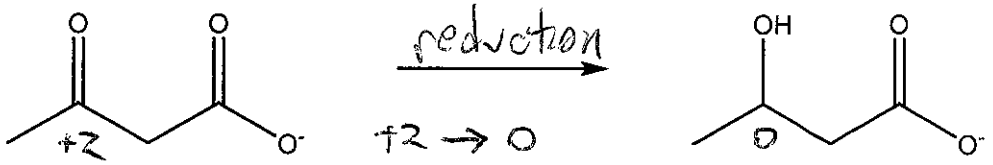


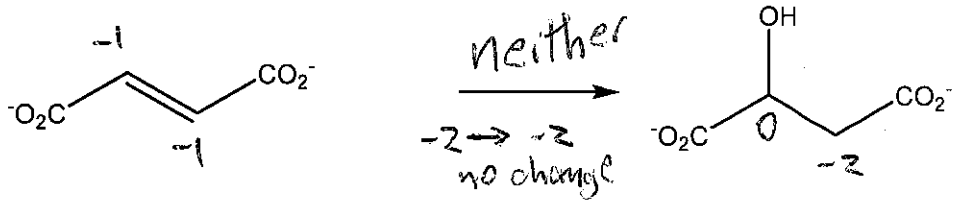
B. In this reaction, two carbon atoms changed. There was, however, no net change in oxidation state between reactants and products for this reaction. It is not oxidation or reduction.

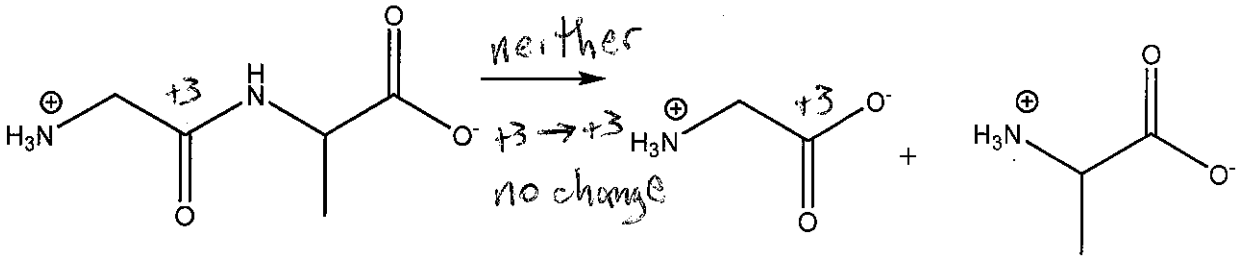


Problem 1: Label each reaction as oxidation, reduction, or neither.

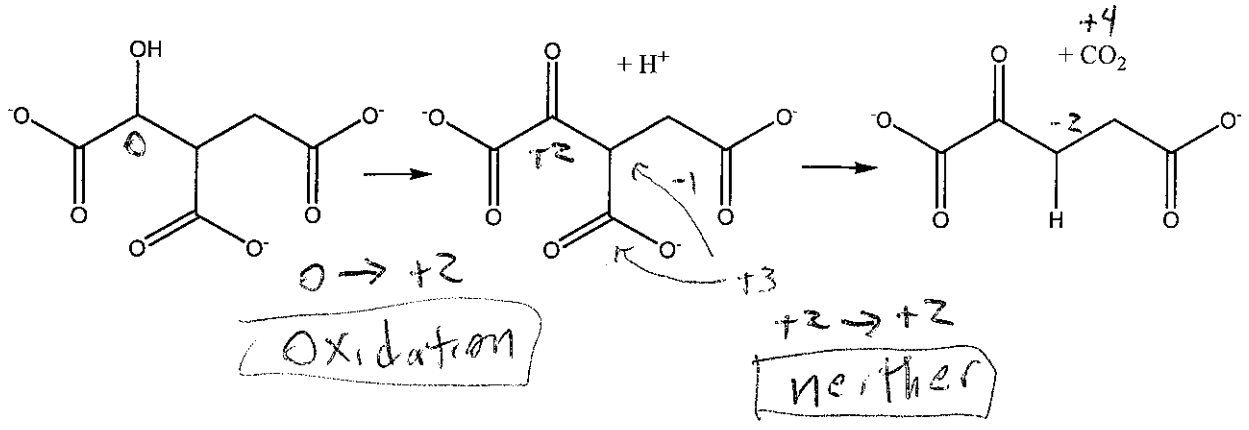








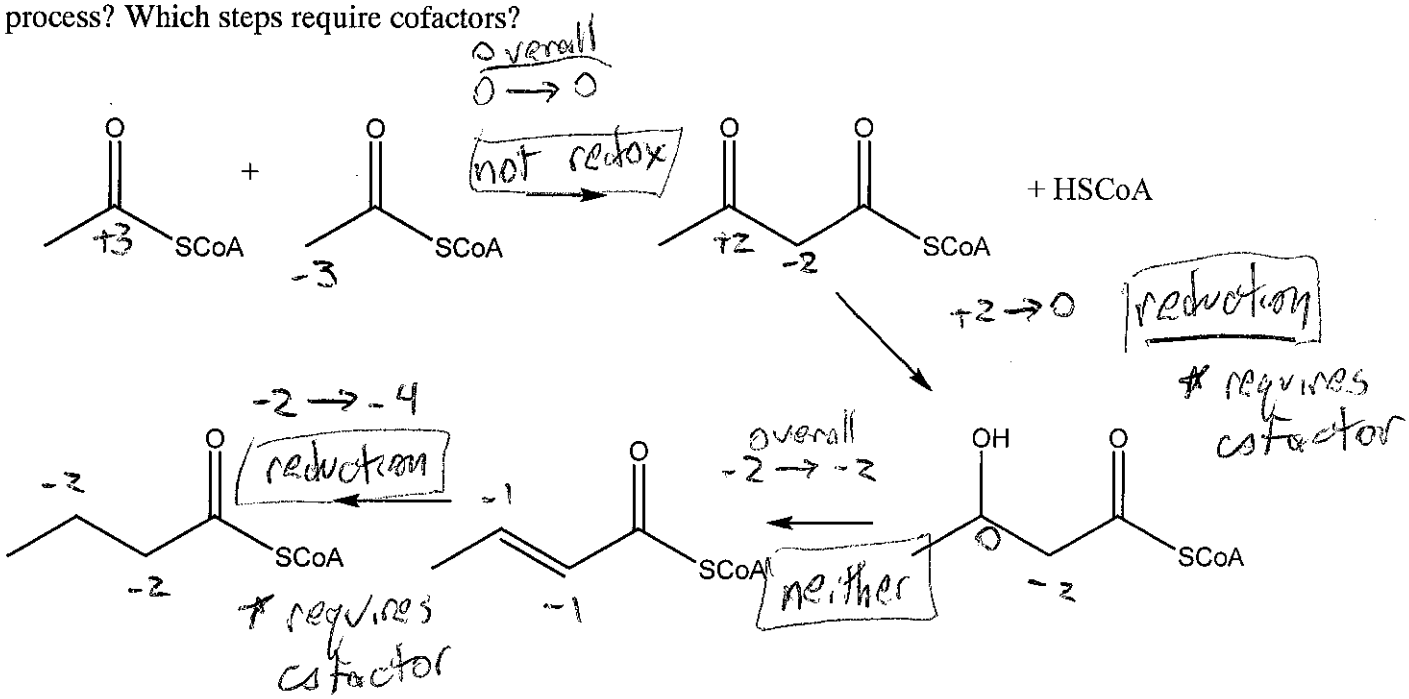
Problem 2: The following reaction sequence is part of the citric acid cycle. Are either of these reactions redox reactions?



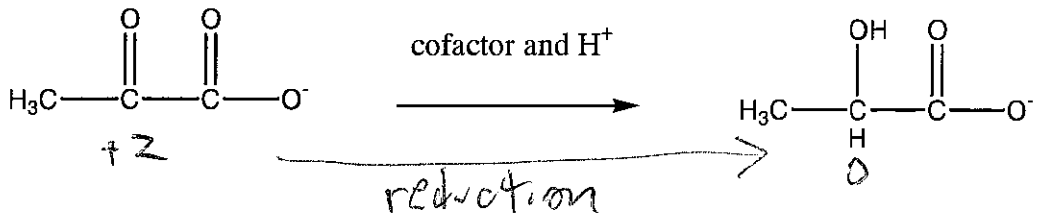
Skill 2: Use redox reactions to predict spontaneity and need for cofactor

- If a metabolite is oxidized, the metabolite loses potential energy.
  - Most oxidations of organic molecules are spontaneous.
  - Oxidation requires a cofactor to be reduced: NAD+ → NADH or FAD → $FADH_2$
- If a metabolite is reduced, the metabolite gains potential energy.
  - Most reductions of organic molecules are nonspontaneous.
  - Reduction requires a cofactor to be oxidized: NADH → NAD+ or $FADH_2$ → FAD

Problem 3: The following are four steps in fatty acid biosynthesis. Is it a reductive or oxidative process? Which steps require cofactors?



Problem 4: Under anaerobic conditions, pyruvate is converted to lactate. What type of reaction is this? What cofactor is needed?



Requires NADH